

Chemical Bonding and Reactions

PS-4 The student will demonstrate an understanding of chemical reactions and the classifications, structures, and properties of chemical compounds.

PS-4.11 Explain the effects of temperature, concentration, surface area, and the presence of a catalyst on reaction rates.

Taxonomy Level: 2.7-B Understand Conceptual Knowledge

Key Concepts:

Reaction rate factors: temperature, concentration, surface area, catalyst

Particle collisions

Previous/Future knowledge: In the 7th grade students compared physical changes (including changes in size, shape, and state) to chemical changes that are the result of chemical reactions (including changes in color or temperature and formation of a precipitate or gas). (7-5.10)
In Physical Science students will expand their concept of chemical reactions. For the first time students will explain factors that affect the rate of reaction. Students will explain the affect that changes in temperature, concentration, surface area, and the presence of a catalyst have on reaction rate.

It is essential for students to

Understand that chemical reactions occur when the particles of the reactants collide with sufficient energy to react. Factors that affect reaction rate are as follows:

- **Temperature:** When the temperature increases, the rate of a chemical reaction increases.
 - The average kinetic energy of the molecules of reactants increases with increased temperatures and a greater number of the molecules will be moving faster.
 - Since more of the particles are moving faster and fewer of the particles are moving slowly, there will be more **total collisions** between particles and more collisions can a mean faster reaction rate.
 - More of the reactant particles will be moving faster and will, therefore, have enough energy to produce **successful collisions** and the reaction will proceed faster.
- **Concentration:** When reactants are more concentrated, the rate of a chemical reaction can increase.
 - When reactants are more concentrated, it means there are more particles per unit volume. Because there are more particles in a given volume, there is a greater chance that reactant particles will collide.
 - More collisions can mean a faster reaction rate.
- **Surface Area:** When the surface area of reactants increases, the reaction rate increases.
 - Only the particles at the surface of a sample of reactant can collide with particles of other reactants.
 - If the same mass of reactants is broken into smaller pieces, there is greater surface area. With many more particles on the surface, there is a greater chance for collisions to occur, and the chemical reaction will proceed faster.
- **Catalyst:** A *catalyst* is a substance that speeds up a reaction without being permanently changed itself. The presence of a catalyst will speed up a chemical reaction.
 - Catalysts can lower the amount of energy needed to start a reaction (activation energy).
 - Since the energy needed for successful collisions is less, there will be more successful collisions, and the chemical reaction will proceed faster.

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It is not essential for students to

- Understand why a catalyst lowers activation energy or define activation energy;
- Understand catalysts that work by a mechanism other than lowering the activation energy such as surface catalysts which affect orientation.

Assessment Guidelines:

The objective of this indicator is to explain how certain factors affect reaction rate, therefore, the primary focus of assessment should be to construct cause and effect relationships that show how and why temperature, surface area, concentration, and presence of a catalyst affect the reaction rate.

In addition to *explain*, assessments may require that students

- Compare reaction rates under different conditions;
- Summarize the effects of changes in temperature, surface area, concentration and presence of a catalyst on reaction rates;
- Infer the effects of changes in temperature, surface area, concentration and presence of a catalyst on reaction rates;
- Recall or recognize factors that affect reaction rates.